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LIGHTING DATA

EDISON LAMP WORKS
OF GENERAL ELECTRIC COMPANY

GENERAL SALES OFFICE HARRISON, N. J.

Lighting of The Food Industries

Information compiled by
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Lighting Service Department

Synopsis

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LIGHTING OF THE FOOD INDUSTRIES

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INTRODUCTORY—

The subject of food production, conversion and manufacture is one of ever timely and important interest, for food has ever been and always will be the most important factor in the health, welfare and general activity of the human race. Without its production and manufacture on the enormous scale which exists to-day, life in its present forms would be impossible, and our leadership as a nation would cease.

It is rather interesting to look back a few generations and observe the radical changes which have occurred in methods of food conversion. One of the many duties then preformed by the sturdy housewife was the preparation of flour and the baking of bread. She would grind by hand the required amount of grain, mix it with the proper ingredients and bake it in her homely oven. Later the duties of grain preparation passed into the hands of the village miller, the producers of his neighborhood bringing to him their sacks of grain for conversion into flour, but still the preparation of dough and the actual baking remained within the confines of the home. Tracing this activity still further, we find that bakeries, to which the formed loaves would be brought for baking, sprung up in villages. As the population increased the business of grain preparation and bread baking likewise expanded, and gradually moved further and further from the home until to-day we have a huge industry bending its entire energies to the efficient handling and production of grain and cereal food and the baking of bread and allied products.

Similarly in the preparation of meats, there was a time when every man was his own butcher, doing his own killing, cutting, smoking, salting, etc., but this work gradually passed into the hands of the village butcher, then through necessity there came local abattoirs and eventually the enormous stockyards, slaughter houses and packing plants of to-day. The evolution of our modern canneries, milk condensing plants, fisheries, etc., has been very much the same. It is with the application of artificial light in these modern industries that this paper intends to deal.

When considering the wonderful progress made in a branch of industry, such as this one, one is naturally prompted to inquire what manufacturing methods are employed and what changes, if any, have been made in plant operating practice since their inception. Do they compare favorably with the practice in other industries, and are they consistent with the character of products which are offered us?

Generally speaking, the methods to-day employed are seemingly the acme of perfection and efficiency. Modern minds have evolved machinery and methods of handling and utilizing food stuffs in ways which were never dreamt of in the days of our forefathers. Sanitary conditions have been much improved and most of our plants are to-day as clean as the proverbial whistle. Progressive manufacturers are to-day utilizing every available agency for promoting efficient plant operation, complying with the stringently enforced pure food laws and acquiring the good will of the public.

Artificial illumination, however, seems to be one factor which has suffered serious neglect in many plants.

Light in some form is a vital element entering into the operating efficiency of every industry. We find that manufacturing buildings are invariably constructed so that the maximum amount of daylight illumination is insured, it apparently being realized that daylight illumination of a high order is well worth having. It seems almost paradoxical then that a good many of these plants which are so well fortified from the daytime manufacturing standpoint have artificial lighting systems which may be considered far from adequate. Artificial light, by many, still seems to be considered a necessary evil and lighting systems under these conditions are merely the application of a lamp bulb, as such, rather than the procurement of real illumination.

In considering the problem of illumination of any industry the first query which confronts us is, "what are the benefits of *good* illumination to this industry?"

The writer in compiling data for this paper interviewed many superintendents and operating men responsible for the efficiency and output of typical food manufacturing plants. One of the questions which was usually placed before these men, was "do you consider good artificial light necessary and desirable in your establishment." In summarizing the replies made to this question,

it was found that the management of those plants with poor lighting invariably contended that their particular industry might be classed as a daylight industry and that in general very little work was carried on during the hours of darkness or under conditions necessitating artificial illumination. On the other hand, it is rather interesting to note that in other plants, almost exact duplicates, as far as products and working hours are concerned. the operating men said that they considered artificial light as being extremely essential and in general these were the plants which had adopted a high intensity of properly applied light to their requirements. When we remember that in the so-called daylight industries there are approximately 300 working days per year in which there is an average of 2 hours per day during which artificial light is required, we can quite fully appreciate that really good artificial light is essential and has a distinct bearing on the plant's successful operation.

This is especially true since the period calling for artificial light occurs at the end of the working day when the vitality and morale of the workers is at low ebb, when they are under the influence of bodily, mental and ocular fatigue. It is at such a period as this that stimulating and elevating influences are required more than at any other time. Inadequate light at such a time is but another millstone added to the already weighty burden of depression upon the worker. Good illumination will tend to keep the curve of production level and that of casualities from rising.

Benefits of Proper Lighting.

There are certain derivatives of good lighting and their relative importance in the food industry seems to be as indicated by the following order of treatment.

A. Sanitation.

To-day the operation of practically all food preparation plants is under the eye of Federal authority. Cleanliness is imperative, for the foods produced are distributed widely and if contaminated in any way whatsoever are liable to carry disease to all parts of the world. Periodical inspections by government authorities are made, not only of the food-stuffs themselves, but of the conditions under which they are manufactured. Cleanliness of a plant as a

whole is something which must undergo the most rigid surveys. That good lighting means cleanliness can be readily appreciated, for with a high intensity of well-diffused light refuse and foreign matter is not likely to be allowed to accumulate, for where the chances of detection are high and where untidiness is easily visible greater care is always taken by those responsible for the possible existence of such conditions. Furthermore, the workers themselves are likely to be more particular in their personal cleanliness. The general aspect of an interior under good lighting in itself conveys the idea of cleanliness and this reacts eventually upon those working beneath the lighting, making them more careful and more particular of their surroundings and themselves.

B. Safety.

Proper intensities of well-distributed light make it unnecessary for the eye to continually readjust itself in moving about from place to place, enable one to perceive clearly at all times, and eliminate the possibility of misjudging the placement of objects, etc. In the food industries much intricate automatic machinery is used, with many moving parts and extremely sharp knives are employed for various cutting operations; accident hazards which can be greatly minimized by properly applied light.

C. Increased Production and reduced spoilage.

In every food industry we find that close visual application of some character is necessary. It is a known fact that good light quickens visual perception, and that further since the eye sees more readily other sub-conscious movements occur much more rapidly increasing output.

To illustrate this we might cite the case of a typical packing house. Here we find an area which is known as the killing floor, to which the cattle are driven, killed, stripped of their hides, and dissected. The actual work of killing requires only a medium intensity of illumination, but on the other hand the successful removing of the hides, which are eventually converted into leather, the cutting of the carcasses and removal of vital organs requires a high intensity of well diffused light. Keen edged knives are employed for this work and the workers must trust almost entirely to their keenness of sight in successfully separating the skin from the fleshy part of a cattle body and the severing of the various organs. Under a low intensity or poor distribution of illumination distinct visual perception is practically impossible.

As a consequence miscutting is likely to occur which will result in the ruination of hides and spoilage of valuable cuts.

Observations on similar operations carried on under good and bad lighting demonstrate most emphatically that the time required to strip and dissect a carcass is very materially less under the well lighted conditions than under the poor. Not only is the man output greater but the quality of his work, the exactness of his cutting, etc., is of a much higher order. This is truly one of the many places where it might well be said that good lighting will make the difference between profit and loss.

A similar example is found in the fruit packing industries. Here operations of the sorting and inspection type are predominant and of greatest import. The fruit is selected not only for size, but also for color and ability to keep. Visual acuity is rendered more keen by the proper grade of light. Fruits of varying hues are more easily and rapidly separated and the possibility of passing low grade, unsalable and decayed fruit is minimized.

D. Indirect Effects.

The effect of good lighting on the morale of the workers cannot be overestimated. The cheery atmosphere which results from good lighting, makes for a more alert, conscientious and enthusiastic attitude. Much of the work done in food manufacturing plants is of a routine nature, perhaps the most trying on the mental state of the individual. In a gloomy atmosphere grouchiness and despondency develop, followed by carelessness and general laxity.

Where a large number of workers are employed in areas filled with benches, machinery, trucks, etc., the problem of labor supervision becomes of considerable import. The average worker of to-day must be watched. He is inclined to loaf and lag if he thinks his superintendent or foreman will not see him. Good lighting because it enables quick or easy perception and eliminates shadows in which workers may lurk, facilitates the supervision of workers and greatly minimizes this problem.

Having briefly discussed the general relation of light to the industry let us next consider the processes as applied to particular products and the detailed methods of illumination which will produce results consistent with the above aims.

The following scheme of treatment will be adhered to as far as possible.

(a) General character of building.

(b) Analysis of the processes of manufacturing.

(c) Present lighting practice.

(d) Recommended practice as to intensity, type of equipment and method of lighting.

(e) Special or peculiar lighting requirements.

Grain Elevators.—Of our many food-stuffs those classed as grain and cereal foods are undoubtedly of the first order of importance. As far back as we can trace through history, we fiid facts relating to the growing and consumption of wheat and corn and to-day grain products still play an important part in our national commerce and our daily menus. The modern grain elevator is the keystone around which is built our enormous grain and cereal food trade.

The primary functions of the grain elevator are to receive via rail or boat bulk grain from the producers, commission agents, etc., to clean, grade, weigh, store and mix these grains and redistribute them to carriers, either by rail or boat for further distribution and manufacture, or to mills for conversion into flour in the case of elevators which are operated in conjunction with such houses.

Grain elevators may be divided into two classes.

In the first, the elevators are what might be termed self-contained, the storage bins and elevating machinery all being under the same roof. In the second, the elevating machinery is grouped in what is called the work house, while the storage is cared for in bins which are separated from the main house, but connected thereto through conveyors.

Elevator houses are huge rectangular structures the older group usually being of wood construction while the more modern houses are of brick or concrete. In the basement and connecting the work house with the bins, are found low ceilinged tunnels through which run belt conveyors. The upper floors usually extend unpartitioned throughout their entire length and breadth and are occupied by the driving machinery, belt conveyors, scales, elevator legs, and various bins. The ceilings are usually quite high and are broken up by projecting spouts, elevating legs, and overhead beaming and supporting members.

The operation of the typical elevator may be described as follows:

Wheat is brought into the car unloading platform, it is then pushed by means of automatic shovels out of the car down into the receiving hoppers. Endless belts carrying small buckets scoop up the grain and hoist it to the very top of the house where it is dumped from the belt, shot into spouts and directed across the top of the building to the garners from where it falls into the scales. From here through swinging turnheads, into spouts and longitudinal conveyors, it goes to certain bins to be held for cleaning or shipping.

These operations are for the most part automatic.

Grain elevator interiors are characterized by their exceptional dustiness and one of the biggest problems confronting the elevator operating men of to-day is that of dust prevention and removal. Much money and effort has been devoted to the elimination of this evil with varying degrees of success. Dust-collecting and removing systems are in use in most modern houses, but even so, during the periods of grain movement, their interiors become practically enveloped in dust clouds. From the standpoint of artificial illumination this presents a serious problem.

The flying particles of dust naturally lodge on all surfaces presented to them. Lighting units are no exception, and they become rapidly coated with a dense layer of more or less inflammable and opaque dust. In going about a mill, it will usually be found that many of the lamps indicate their presence solely by a mere glow. Aside from the standpoint of light absorption, the prevalence of dust presents another serious problem, that is one of fire hazard. As a result of the many explosions which occurred in grain elevators during the period of the World War, the United States Grain Corporation, under whose supervision grain handling was then being carried on, in co-operation with the Bureau of Chemistry of the United States Department of Agriculture, conducted a dust explosion prevention campaign, and a survey of the causes of grain dust explosion.

One of the inferences drawn from this survey was that the incandescent lamp at times presented a fire hazard. The leading lamp manufacturers upon being acquainted of this fact inaugurated a survey of their own. with a view towards finding out if it

really was dangerous to use the incandescent lamp in such interiors and how they could best be applied with safety. A recapitulation of the results of this survey was presented before the society during the Annual Convention September 26-29th, 1921, in a paper entitled "Incandescent Lamp Temperatures as Related to Modern Lighting Practice." As was pointed out at that time, it was found that fires or explosions which may be caused by incandescent lamps in dusty atmospheres are of two kinds.

First: In extreme cases, fires resulting directly from the ignition of dust accumulating on the lamp bulb.

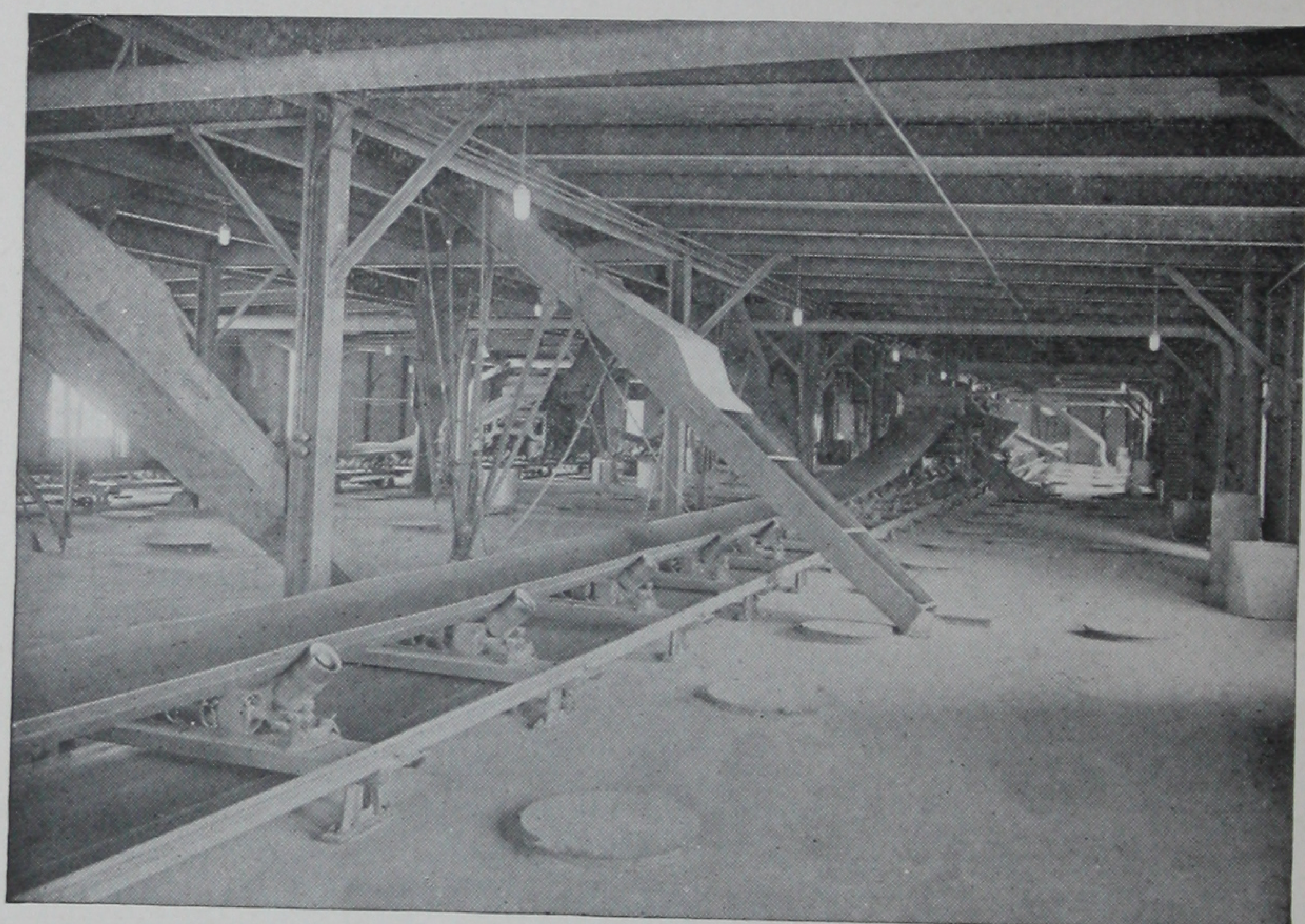

Fig. 1.—Day view illustrating typical conditions encountered in a grain elevator, 25-watt Mazda B lamps in vapor proof globes on centers 12 x 14 feet. Absence of reflectors and dust accumulation results in decidedly low utilization of light, average intensity less than 0.5 ft.-c. Inadequate as it may seem it pictures one of the best installations inspected.

Second: Explosions resulting from the accidental breakage of lamps in a dusty atmosphere containing the proper proportion of air and dust to form an explosive mixture.

By the proper application and protection of lamps, the possibility of trouble due to either of these causes may be eliminated. The hazard attending the use of high wattage lamps in general overhead lighting systems is far less than that resulting from the careless use of small hanging lamps on drop cords.

Present day practice as indicated by Table I is in general unsatisfactory.

TABLE I.—LIGHTING STATISTICS COMPILED FROM INSPECTION OF 100 TYPICAL HOUSES RANGING FROM 60,000 TO 4,500,000 BUSHELS CAPACITY [1]

Kind of Lighting		
Plants using Oil Lanterns		1
Plant using Gas		0
Plants using Electricity		99
Types of Lamps		
Plants using all carbon lamps		21
Plants using all tungsten lamps (Vacuum)		42
Plants using all tungsten lamps (gas-filled)		1
Plants using carbon and tungsten Vacuum		26
Plants using carbon and tungsten gas-filled		5
Plants using carbon vacuum and gas-filled		4
Plants using oil lanterns		1
Use of Reflectors		
Plants using no reflectors		85
Plants using some reflectors		11
Plants entirely equipped with reflectors		4
Vapor Proof Globe Protection		
Plants using no V. P. globes		41
Plants partially equipped		46
Plants entirely equipped		13
Types of Reflectors		
Plants using all drop cords		53
Plants using all ceiling sockets		2
Plants using ceiling sockets and drop cords		9
Plants using ceiling sockets and wall brackets		5
Plants using drop cords and wall brackets		18
Plants using drop cords, ceiling sockets and wall brackets		13
Types of Wiring		
Plants using all conduit wiring		51
Plants using all open wiring		32
Plants using open and conduit		17
Lamps		
Average number of lamps per plant		230
Average size lamp used	(watt)	40-50

The usual procedure is to apply bare incandescent lamps, usually Carbon or Mazda B in the 25, 40 or 60-watt sizes on drop cords at intervals of about 20 feet, and a hanging height of approximately 6 ft. above the floor as shown in Figure 1. The resultant distribution of illumination is very non-uniform; the intensity is low, the light sources which are in the range of vision are decidedly uncomfortable and the breakage risk and consequent fire hazard is very great. The claimed advantage of such

[1] Since 100 is the basic figure the representative number are also equivalent percentages.

practice is that the low hanging height makes it possible for the workers to readily clean lamps by wiping them with their hands as they pass along. Some of the more modern mills apply low wattage lamps in vapor proof globes at more frequent intervals, sometimes mounting them on the supporting columns, using a rigid mounting. This practice is substantially better and in mills of the more modern type with light surroundings, fairly good illumination is secured.

There is undoubtedly a large field in this industry for the use of higher wattage lamps in conjunction with vapor-proof globes equipped with reflectors and where necessary, guards affording protection from mechanical injury. (Fig. 2). The economy, minimization of fire hazard and improved lighting effect procurable should more than justify their installation. A well-designed unit is not unduly susceptible to the accumulation of dust and undoubtedly many of the fixtures now available on the market are quite satisfactory.

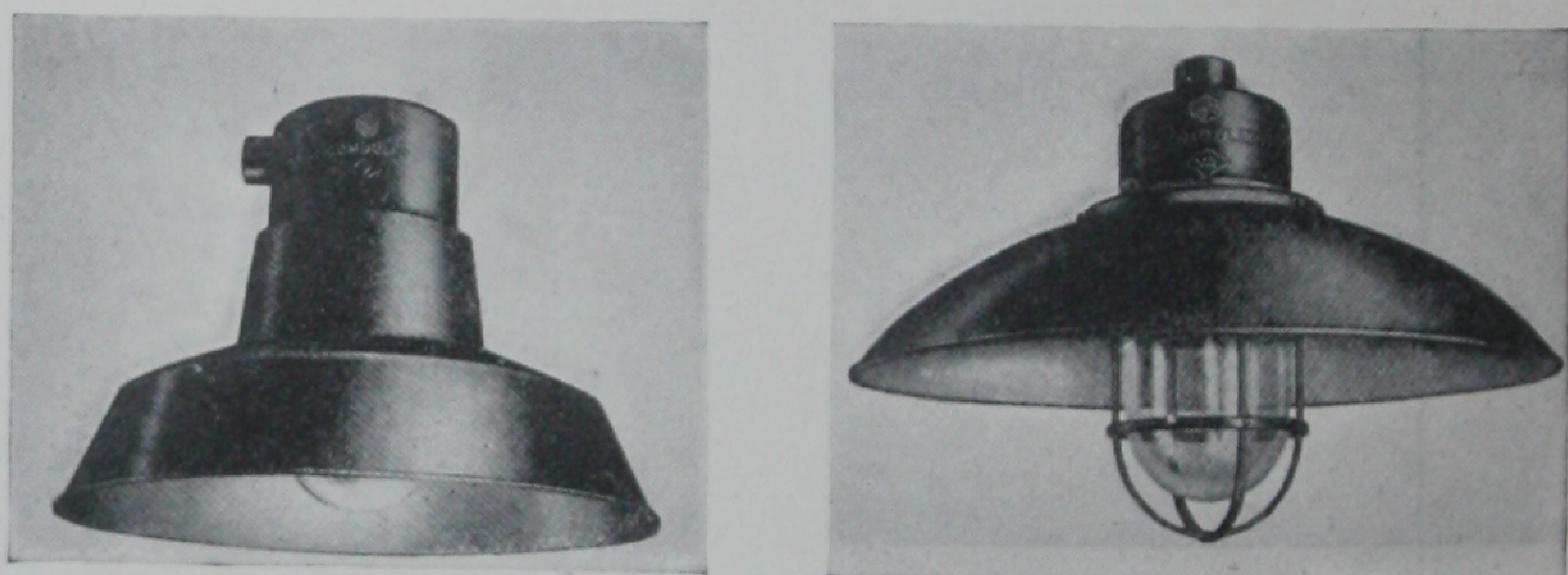

Fig. 2.—Typical vapor proof reflector of the type recommended for grain elevators and flour mill lighting.

The demands for lighting in the grain elevator are, for safety, for the carrying on of rough operations such as the setting of belt trips, grain spouts, etc., and for some little closer visual work as the reading of scales. Intensities of from 0.25 to 1 foot-candle are to-day being almost universally employed for this work. These values of illumination are undoubtedly low and a substantial increase to intensities in the order of from 1 to 3 foot-candles should be adopted, for by so doing safety in working conditions would be materially bettered, in fact to such an extent that the increased wattage could be easily justified. Furthermore, the application of Mazda C lamps in suitable reflectors equipped with vapor-proof

enclosing globes will make possible the procurement of a more uniform, efficient and comfortable distribution.

There are some areas in and about the average elevator which require other than general lighting, these being the scales, bins, freight cars, docks and ship holds.

In front of each hopper on the scale floor (the point where the incoming and outgoing grain is weighed), is a beam scale calibrated with figures varying in height from one-fourth to one-half inch It is essential that these scales be read accurately and rapidly.

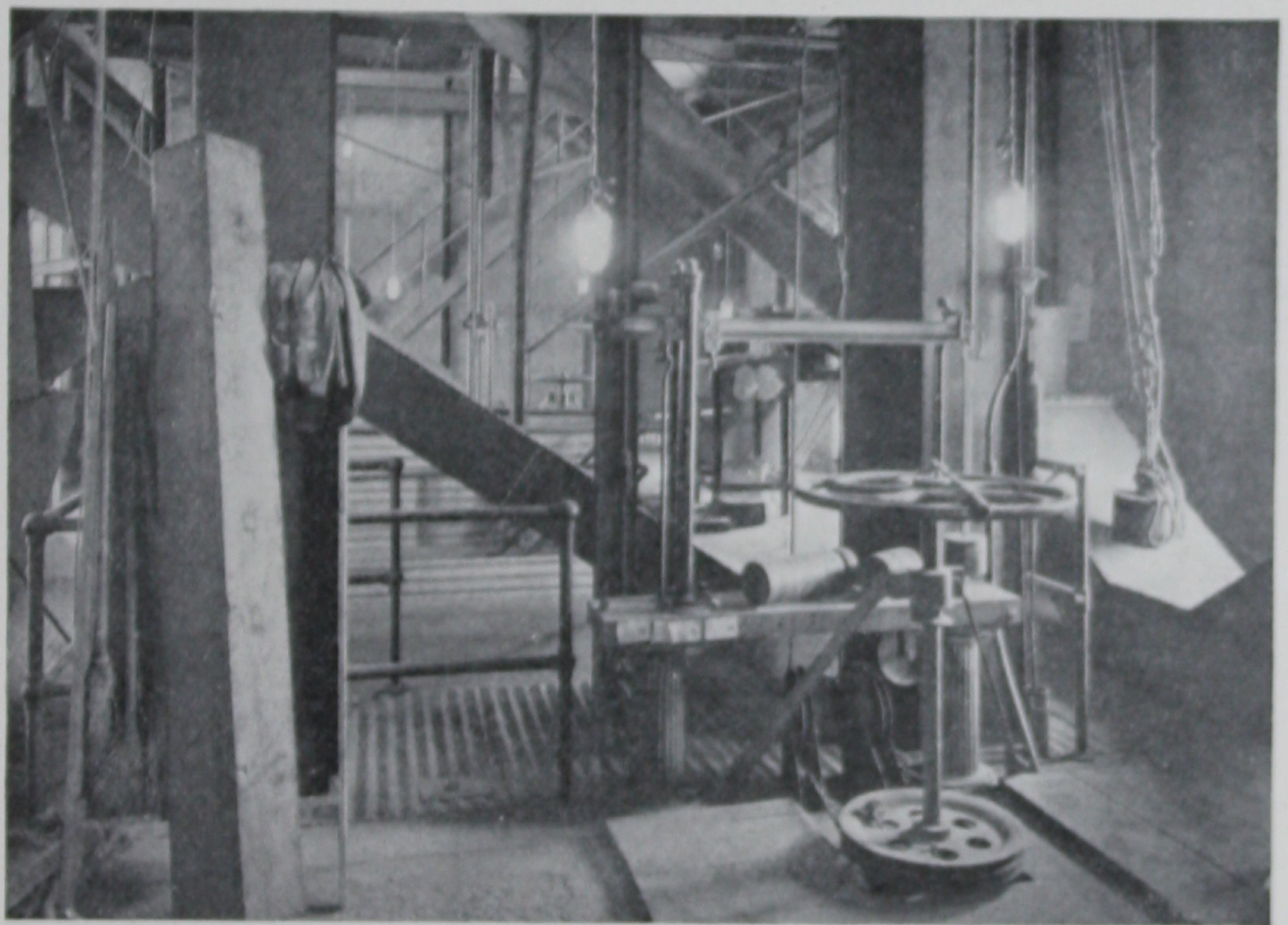

Fig. 3.—Day view of scale floor in grain elevator, unshielded lamps are almost directly in line with scale beam on which none too distinct figures must be read. Angle type or dome reflectors should be used here to provide "light on the object and not in the eye."

The proper kind of illumination undoubtedly is an important adjunct to the attainment of these ends. The present practice consists for the most part of using one or more low-hanging bare lamps directly in front of the scales and usually on the normal line of vision, Fig. 3. This procedure is far from being good and a practicable solution of the lighting problem seems to be to mount one or preferably two dome shape reflectors, carrying 75-watt Mazda C lamps, about 3 feet above the level of the arm.

In the lighting of grain storage bins we have a rather interesting problem, and one whose satisfactory solution is an objective which has often been the hope of many operating men. Unfortunately, most operators have held hope but have taken no real steps towards investigating ways and means of attaining a satisfactory solution. Grain bins are in reality tanks ranging in depth from 60 to 90 feet in which grain is stored prior to shipment. It is frequently desired to look into these bins for the purpose of determining grain level. It also becomes necessary at times to enter the bins for the purpose of cleaning. The theoretical method of establishing the grain level is by means of a plumb line, while actual examination is made under the illumination furnished by a carbon or Mazda B lamp of low wattage mounted on a drop cord, in fact in 99 out of 100 plants inspected this practice is held. Unfortunately the common tendency of workers at these points is to use the lamp and cord as a plumb line. The lamp and cord are lowered into the bin and the cord is quite frequently chaffed or broken, causing short circuits and further are often left hanging in the bin only to be covered by grain at some later time. This is obviously an extremely dangerous practice and there are on record cases of fires and explosions which it is claimed can be directly traced to this cause. The ideal method of lighting these bins would be by means of a portable unit which could be mounted at the opening, projecting its rays into the bins and lighting the interior to an intensity of, in the order of one-half to one foot-candle. During the movement of grain, one of the most usual intervals of inspection, the interiors of these bins are enveloped in dust clouds. The lighting supplied at the opening must penetrate this cloud.

Apparently, the most practical unit for this service is a searchlight carrying a standard voltage lamp. One of the large railroad export elevators is now using such a scheme to its entire satisfaction. Outlets are situated at convenient points over the bin floor, and units which are hung at readily accessible points may be taken when needed and located at whatever bin requires light, It becomes unnecessary for lamps or current carrying parts to be lowered into the bins themselves, and ample light is had throughout the interior even under the most adverse conditions.

It quite frequently happens that ships must be unloaded or loaded at night, in which event artificial illumination of some

means must be had. For exterior illumination of this character it is the usual procedure to mount flood lights on convenient parts of the building training them on the areas where illumination is required. For lighting the ship holds, clusters of 60-watt lamps in a dome steel reflector fitted with a wire protecting guard and arranged for convenient plugging into receptables mounted along the deck side of the building are usually employed, while lighting the interior of cars is cared for in a somewhat similar manner. Undoubtedly a better effect and more efficient illumination could be secured at these points by the utilization of a dome-shaped vapor proof unit equipped with a guard and a Mazda C lamp, preferably bowl enameled, of a suitable wattage.

The following tabulation indicates the recommended lighting practice for grain elevators.

Section	Type of illumination	Intensity ft-c.
Machinery floor	General	3-4 ft.
Garner floor	General	1-3 ft.
Weighing floor	General and local	1-3, 8-10 ft.
Bin floor	General and local projectors	1-3, ½-1 ft.
Cleaning	General	1-3 ft.
Conveyor passageway	General	1-3 ft.
Deck and dock	General (Floodlighting)	1-3 ft.
Cars and ship holds	General	3-4 ft.

Flour Mills.—Closely allied to the grain elevator is the modern flour mill wherein grainstuffs are converted into flour. Present day mills range in size from those which convert but a few barrels a day to those having a daily output that ranges well into the thousands, but regardless of their capacity the operations performed and the lighting demands are much the same.

Flour mill construction is quite similar to that of grain elevators. Old construction is characterized by the multiplicity of cross-beams, struts, etc., necessitated by the type of architecture. Modern practice, however, closely approaches standard factory construction. As in the case of elevators, the upper areas are broken up by conveyor tubes, spouting, etc. The machinery employed in various operations is usually arranged in rows with those parts demanding most light facing the windows.

The processes employed in flour milling involve a seeming multiplicity of treatments, but the main objectives may be classed as cleaning, tempering, separation of middlings and reduction to

flour.[2] These operations are all of a semi-automatic nature, and the product is not touched by human hand from start to finish, being passed from operation to operation through spout conveyors.

Artificial light application in the majority of mills is very poor. The customary procedure is to place low wattage Mazda B lamps on drop cords at the place where light is desired (note Fig. 4) without regard to the procurement of efficent utilization, uniform distribution, or prevention of glare. As a consequence, interiors are usually gloomy, eye fatiguing, and even dangerous because of the prevalent shadows.

General lighting is most admirably adopted to the flour mill (see Figures 5 and 6), and can be best secured by the use of suit-

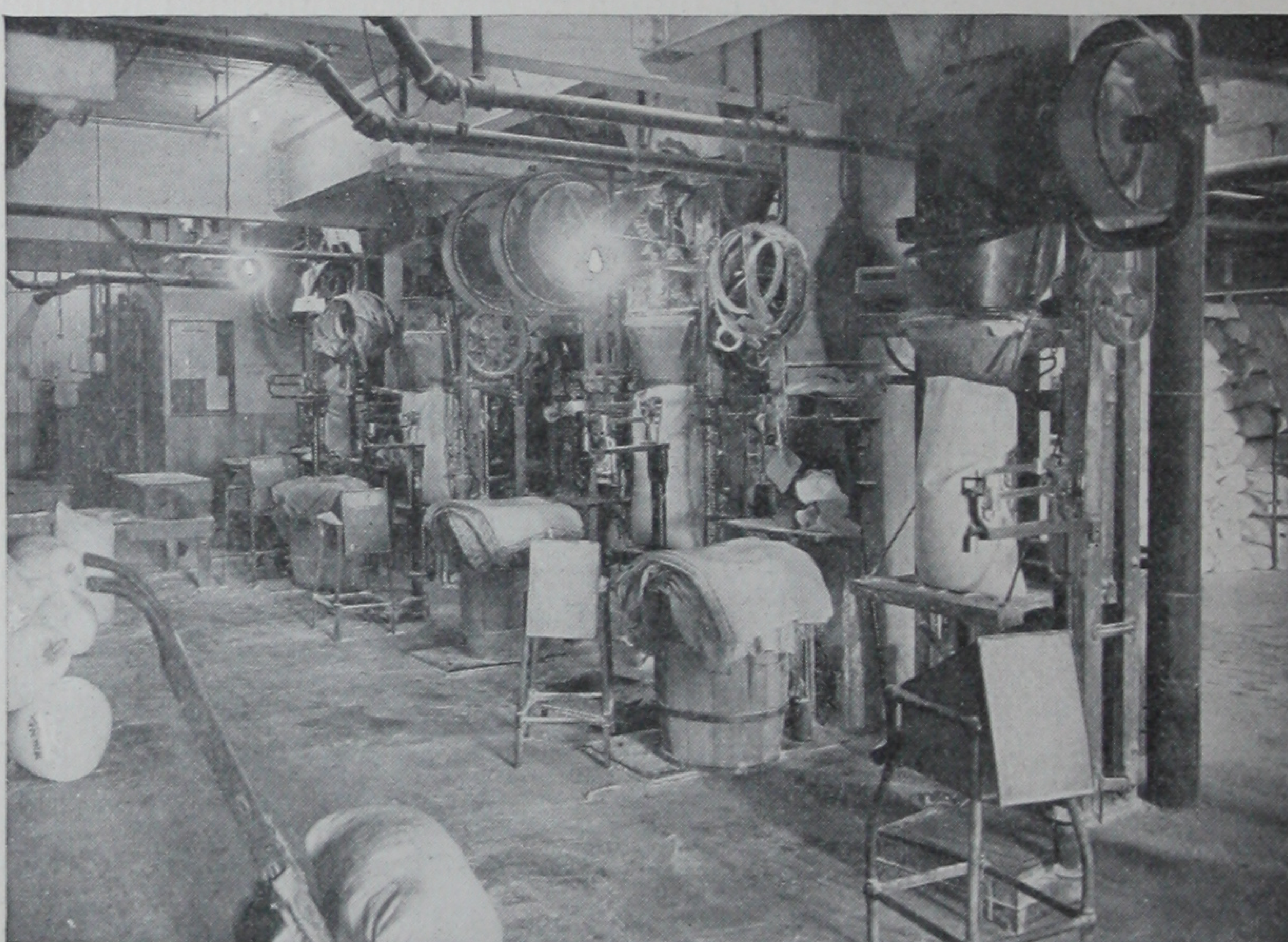

Fig. 4.—Day view indicating the character of lighting often employed at the bagging and weighing machines in the flour mill, a few 25-watt bare lamps are haphazardly placed and pulled over to some chosen position by a piece of string.

ably spaced gas-filled lamps in steel dome reflectors, preferably equipped with vapor-proof globes. (See Fig. 2).

In modern flour mills laboratories are maintained for the inspection and testing of flour with regard to grade, bread-making qualities, etc. In addition to the general system of lighting of high

[2] For a detailed discussion of the process involved, see "Food Industries" by Vulté and Vanderbilt, pages 62-74. Publishers, Chemical Publishing Company, Easton, Pa.

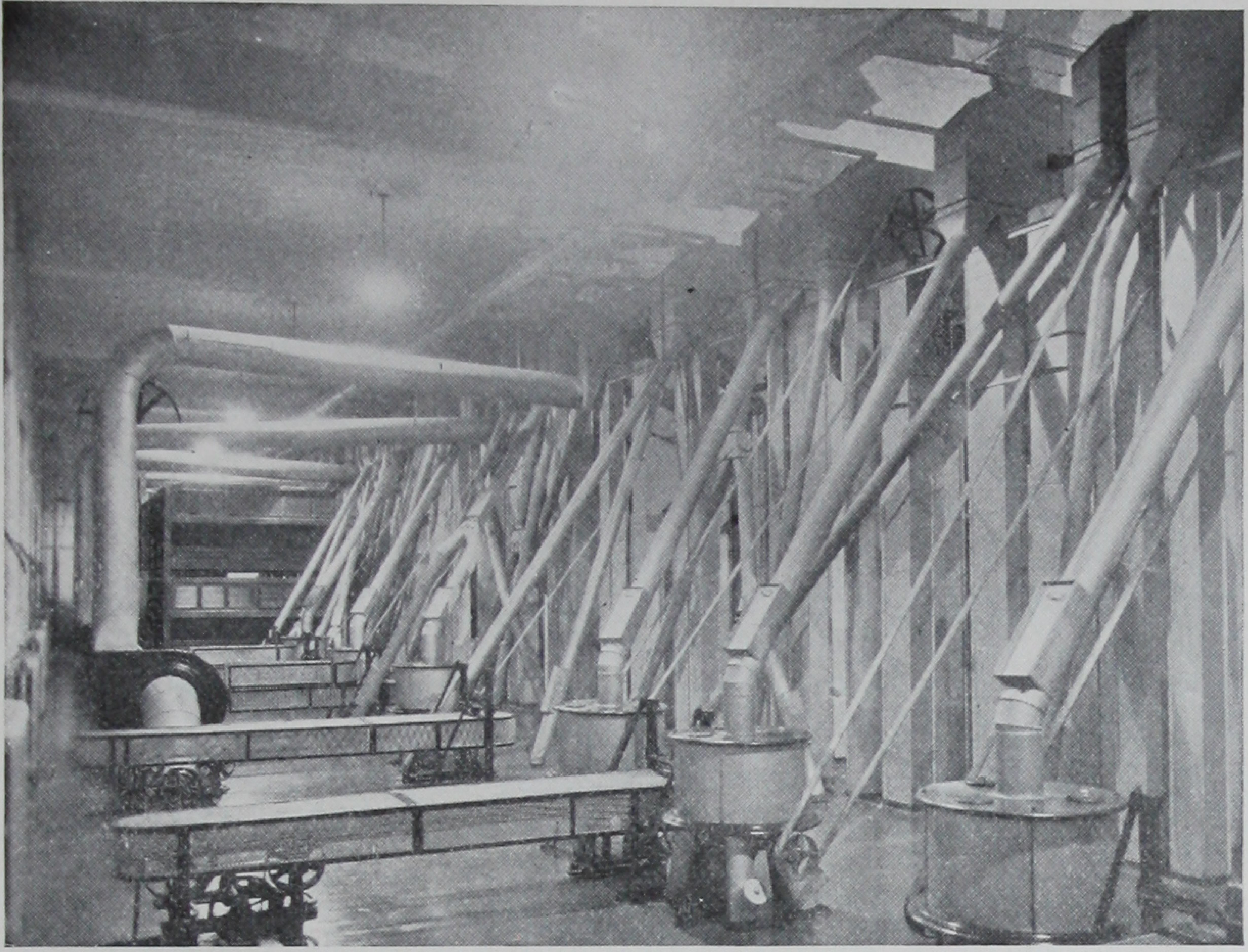

Fig. 5.—Night view of modern lighting applied to elevator heads and bolter distributors in a flour mill, 150-watt bowl enameled Mazda C lamps in RLM standard dome reflectors are used on 16-foot centers, 13 feet above the floor, they provide an intensity of 5 ft-c. The white surroundings aid the sanitary conditions and promote utilization of light.

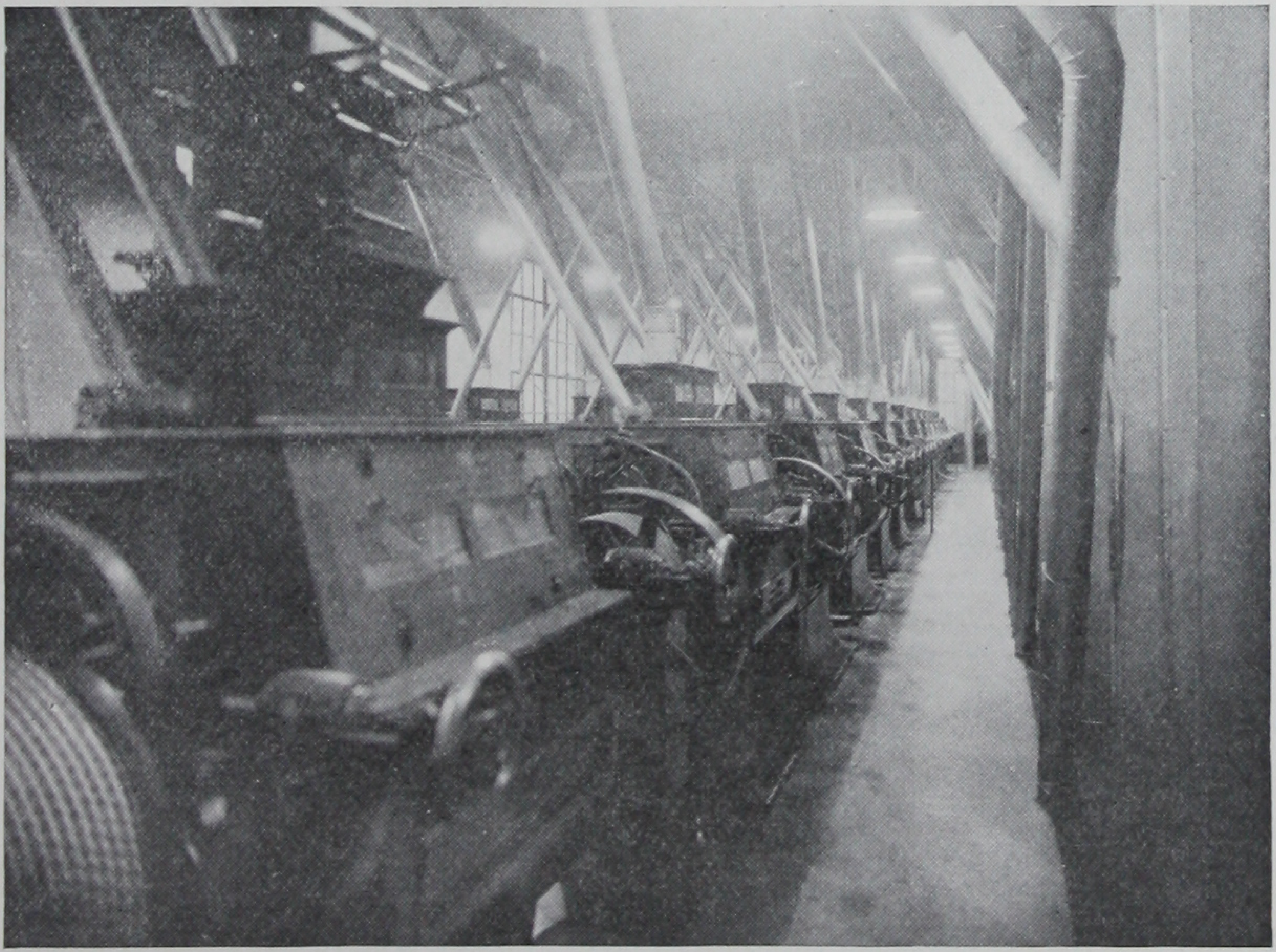

Fig. 6.—High level lighting of the roller floor in a progressive flour mill, 150-watt bowl enameled Mazda C lamps in RLM standard dome reflectors are 10 feet above the floor on centers 8 x 10 ft, the intensity is over 12 ft.-c.

intensity which should be provided in such an area, color-matching units are found to be highly valuable, inasmuch as they enable the accurate discrimination of slight variations in color regardless of natural light conditions. Such units are now being employed in some of the progressive mills.

The following intensities are recommended as a guide for good lighting practice.

Process or operation	Type of illumination	Intensity ft-c.
Cleaning, grinding, rolling, separating	General	3-6
Bagging and weighing	Localized general	6-8
Grading	Local	10-20

Breakfast Food Manufactories.—The breakfast foods produced under various trade names are far too numerous to discuss in so far as their manufacturing pecularities are concerned in an article of this character. It was found, however, that the procedure involved parallels very closely that described in a typical flour mill plus cooking, baking, steaming, and the like.[3] Breakfast food manufacturies are usually of standard mill type construction characterized by large window areas producing good daylight conditions. Artificial lighting practice varies widely, although the trend as indicated in new construction is toward high grade general illumination. Many of the older plants inspected were found to be using a haphazard system of B lamps on drop cords, and as a contrast to this were found modern plants at the other extreme using well planned systems of totally indirect lighting.

The following tabulation indicates the recommended lighting practice.

Process or operation	Type of illumination	Intensity ft-c.
Cleaning, grinding, rolling	General	3-6
Baking and roasting	General	5-10

Bakeries.—Bakeries may be grouped with reference to character of product into three general classes, as bread and cake baking, cracker and biscuit baking and pie baking. The establishments of a given group in themselves vary widely in character, from the small cellar or backroom retail variety producing on a small scale and largely by hand, to the huge specially-constructed well-ventilated sunlight factory type building containing acres of floor space and producing enormous volumes by means of highly developed automatic machinery for wholesale distribution.

[3] For a detailed discussion of the processes involved in breakfast food manufacture, see "Food Industries" by Vulté and Vanderbilt, pages 75-80. Publishers, Chemical Publishing Company, Easton, Pa.

In bread making the operation consists, broadly speaking,[4] of mixing, raising, dividing or forming, baking and wrapping. In the smaller establishments many of these operations are carried on by hand and wrapping is an unknown quantity. On the other hand, in the large institutions the operations are all carried on by automatic machinery and the product is not touched by human hands from the time the ingredients are mixed until the loaf is placed in the shipping trays.

Fig. 7.—A rare example of modern lighting applied to the mixing and bake room of a progressive medium sized bread bakery. The 18 x 18 feet bays in front of the ovens are illuminated by centrally located 200-watt clear Mazda C lamps in RLM standard dome reflectors producing a resultant intensity of approximately 3½ ft.-c.

Crackers and biscuits are numerous in variety, ranging from the well-known soda cracker to the heavily candied and fruited cracker which might almost be classed as confection. The manufacturing operations in this phase of the industry, in addition to those encountered in bread-making consist of the preparation of fruits, nuts, icings, etc., and the application of these. By far the major part of this class of product is made in huge establishments by automatic and semi-automatic machinery.

Pie baking involves, in addition to the usual blending and mixing processes, the preparation of fillers such as fruits and custards, and their introduction into the molds. Fruit-peeling in some

[4] For a more detailed discussion of the operations involved in baking see "Food Industries," by Vulté and Vanderbilt, pages 81-106, Publishers, Chemcal Publishing Co., Easton, Pa.

cases is carried on by hand, while in others specially designed machines are utilized. The sorting of fruits, the picking of raisins and similar operations, depend to a considerable extent on the human element, and good lighting is a vital essential in maintaining the product at a high grade.

The survey indicates that the majority of baking establishments are using lighting systems which are far below a satisfactory and economical standard. In fully 50 per cent of the plants inspected reflectors were found to be a practically unknown quantity and vacuum lamps ranging from 25 to 60 watts were the prevailing light sources. Light distribution is an element very seldom

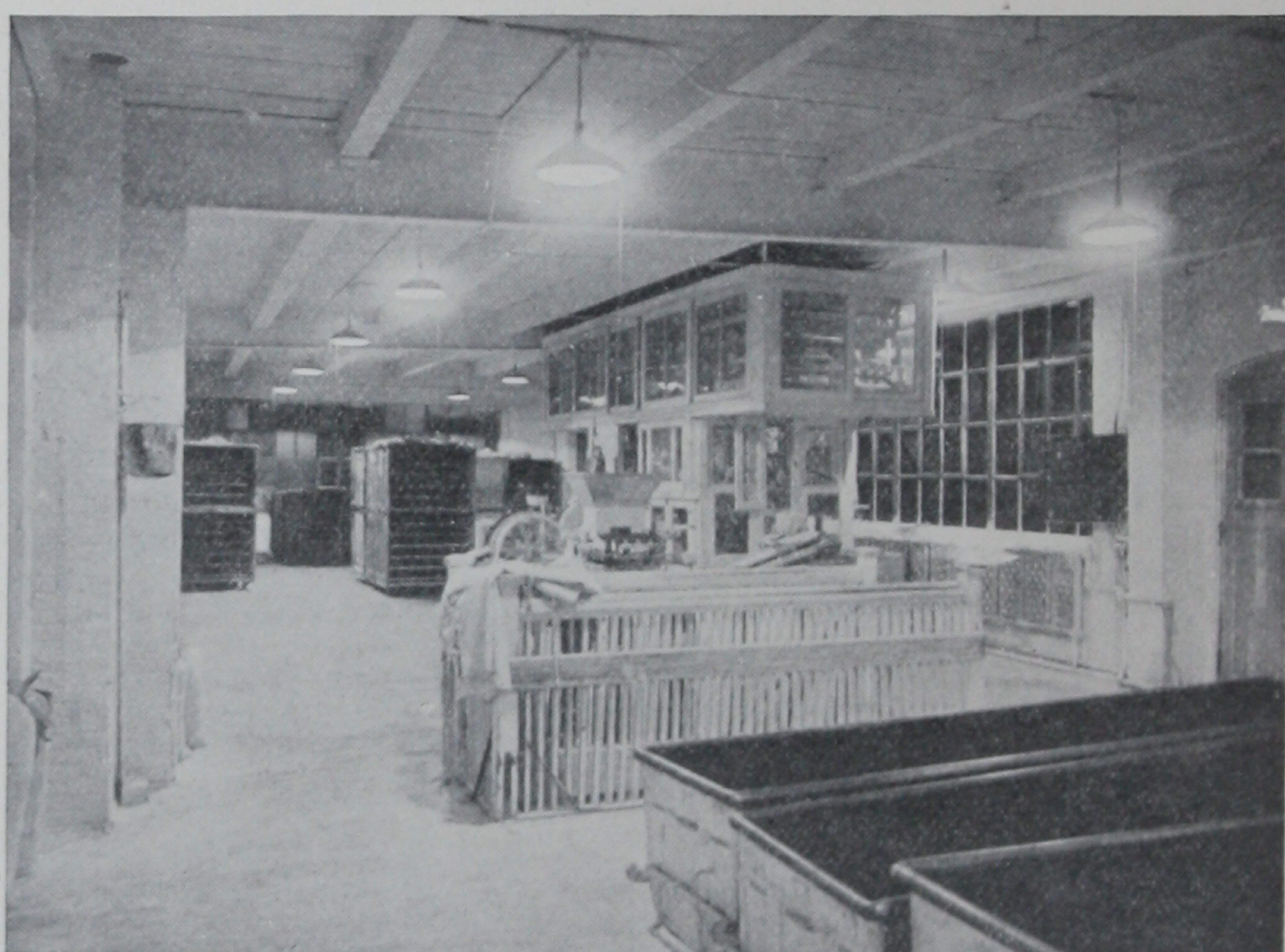

Fig. 8—Night view of dividing and raising room of a well-lighted bread bakery, 100-watt clear Mazda C lamps in RLM standard dome reflectors on 9-foot centers provide a working intensity of 8 ft.-c.

found to receive consideration and the prevalence of glare caused by unshielded light sources is almost as universal as the use of electricity as an illuminant itself. Many large and otherwise high-grade modern plants and in fact some even under the course of erection were found to be planning the use of lighting systems which would result in intensities ranging from 1-2 foot-candles. The surroundings in these plants are usually finished

in white to promote cleanliness and light utilization as a consequence is fairly good. However, the average run of intensities is from one-half to 2 foot-candles and in line for substantial betterment. (See Figures 7, 8, 9 and 10).

During the course of baking it frequently becomes necessary to observe progress. For this purpose artificial light other than that furnished by an overhead general system is required and several schemes are in vogue. The simplest consists of the use of a low wattage bare lamp mounted on an extention cord which

Fig. 9.—Night view of biscuit rolling, forming and baking room illuminated by 100-watt Mazda B lamps in flat porcelain enameled steel reflectors hung approximately 12 feet above the floor, on 18 x 24-foot centers providing an average intensity of one and one-half foot-candles. This presents another example of the unsatisfactory lighting conditions existing in many otherwise modern plants.

is inserted at the front of the oven when inspection is made. This scheme, is very poor, inasmuch as the light source is usually in the line of vision and there is a great likelihood of lamp breakage. Another common practice is to mount a bare low wattage lamp in one corner of the oven, occasionally with a reflector behind it, sometimes continuously in circuit and sometimes arranged for plugging in during inspection. Inasmuch as the baking temperature ranges from 500° to 750° F. short lamp life results from

such practice, a week or ten days being the average time of satisfactory performance. Although special lamps having special treatment in such matters as glass, basing cement, solder, exhaust, etc., have been developed for use in such locations their life performance is not sufficiently better than that of regular lamps to warrant their adoption.

Several oven manufacturers, apparently realizing the weakness of these makeshift schemes, build special lighting equipment in their ovens. The lamp application in such cases usually takes

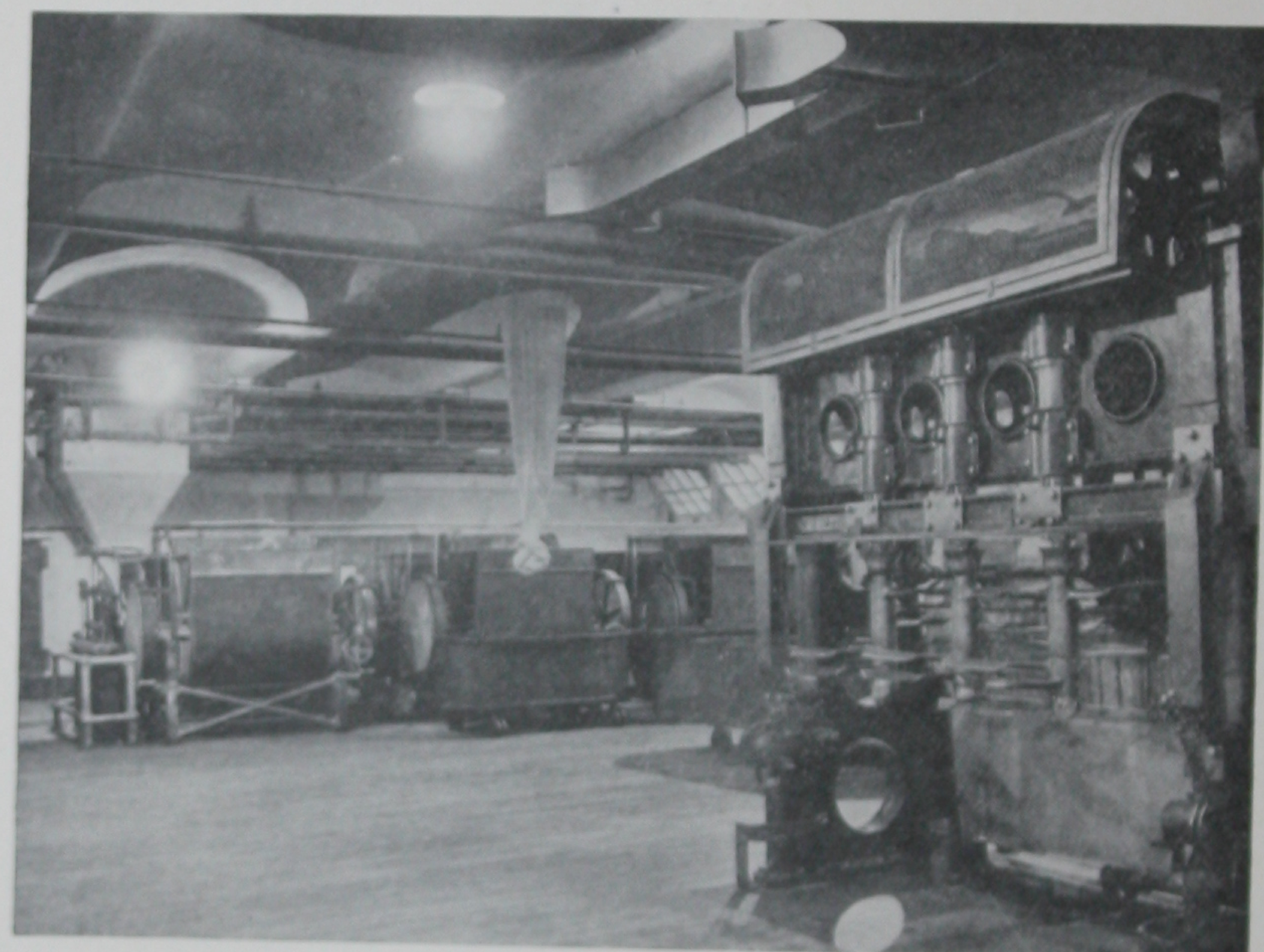

Fig. 10.—Night view of dough mixing department in a large bakery. A working intensity of approximately one and one-half foot-candles is provided by 100-watt clear Mazda C lamps in flat porcelain enameled steel reflectors mounted 12 feet above the floor on 18 x 20-foot centers. The glaring light sources and low intensity are characteristic of the conditions found in many so called modern plants.

one of two forms. One arrangement consists of a swinging arm mounted without the oven holding a housing with a glass front a reflector and a 40 or 60-watt Mazda B lamp. This arm may be swung into the oven and light secured over the bake at the time of the inspection. Inasmuch as the oven door cannot be closed when the arm projects through the doorway, the possibility

of having the lamp at oven temperature for any appreciable length of time is eliminated.

The other scheme employs a unit which is built in a port in the front oven wall. It consists essentially of a cylindrical shell pivoted at the center one-half being of cast iron and the other mica, with a low wattage lamp and reflector mounted within. Normally the cast iron section faces the interior of the oven, the lamp being on the outside. When inspection is made the cylinder is turned on its axis, by a handle provided for that purpose, and the light thrown where desired. The only fault with this equipment is that the operators in carelessness frequently fail to turn the lamps back to the outside position.

Gas-filled lamps are found to give a better life performance in this service than vacuum lamps.

The following tabulation indicates the recommended standards of illumination for this class of work.

Process or operation	Type of illumination	Intensity ft-c.
Blending	General	4-6
Mixing	General	4-6
Dividing and forming	General	4-6
Fruit sorting and peeling	Localized general	10-15
Raisin picking	Localized general	15-18
Baking	General	4-8
Icing	General	4-8
Wrapping	General	4-6

Canneries.—Canning as an industry in the United States dates back to 1819 when the packing of marine products was undertaken on a small scale on our eastern coast. Western emmigration and the necessities of war caused an enormous expansion in this method of food preservation and to-day it embraces the treatment of a vast array of foodstuffs as fruits, vegetables, meats, marine products, milk and the preparation of many specialties.

Fruits, vegetables and most varieties of canned fish are seasonal products whose production occurs over a very brief period of time. As a consequence in plants handling foods of this kind, it becomes necessary to carry on work almost continuously during the flush season and until the run of raw material is exhausted. The need for high grade artificial light under such conditions is quite obvious.

On the other hand, there are many canneries whose products are of the year round variety as for example, soup, bean and milk

canneries and in which working hours are much the same as encountered in the average industry.

Those plants which work but a few months during the year are in most instances crude roomy structures, built solely to offer protection from the elements, while those whose production is of a more constant order are usually housed in substantial buildings of typical factory construction.

The first important operation in canning is that of the grading of raw materials with reference to size and quality.[5] The former discrimination in the case of fruits and some vegetables is made by machines while in the case of most other products this operation depends upon human accuracy. Quality grading is undoubtedly one of the most important of processes and depends entirely upon the visual accuracy of the worker.

Other preliminary operations vary widely depending upon the product treated. Some materials require but very little preparation while others must be pitted, cored, peeled, husked, etc. Various methods of accomplishment are employed some utilizing machinery and others depending entirely upon the skill of the worker. Washing, the next operation, is purely mechanical and is followed by blanching or parboiling, can-filling, processing and cooling.

Present day artificial lighting practice in this industry varies widely. Managers of many large modern canneries, realizing the benefits of high intensity properly applied light, have adopted commendable systems to their requirements. In such plants general lighting employing from ¾ to 1 watt per square foot is being used with localized general lighting at preparation tables and can inspection benches. In the small institutions, however, and particularly those who function but a few months a year the lighting application is rather poor and consists for the most part of the indiscriminate application of bare lamps.

In recommending desirable lighting practice for this phase of the food industry too much stress cannot be laid upon the importance of uniform distribution and adequate intensity, particularly in the cutting, peeling and various preparatory operations. Provision must be made so that shadows will not be cast in front of the operators as they sit and cut or sort. The psychological ef-

[5] For a more detailed discussion of the operations involved in modern canning see "Food Industries," Vulté and Vanderbilt, pages 251-262, Publishers, Chemical Publishing Co., Easton, Pa.

fect of lighting on employees is also an important consideration inasmuch as the majority of workers are women and as commonly known the working efficiency and general welfare of this class of labor is influenced to a marked degree by the working atmosphere. General lighting with localized units at the points previously mentioned, answers all the lighting needs in the canning factory.

In many canneries, as for example, in the canning of peaches, there are as many as five or six distinctive grades of product. In order to discriminate these from the bulk as received, exceptionally good lighting is obviously necessary. Daylight Mazda Lamps are found to be extremely helpful in the discrimination of color, quality and blemishes, and should be employed where such work is carried on. Accurate color matching units, are also invaluable in the laboratories where color comparisons and tests are made.

The following tabulation indicates the recommended practice for the lighting of canneries.

Process or operation	Type of illumination	Intensity ft-c.
Grading	Localized general (daylight lamps)	10-15
Peeling, pitting, husking, cutting, etc.	Localized general	8-12
Washing	General	4-8
Blanching	General	4-8
Can filling, exhausting and closing	General	4-8
Can inspection	Localized general	10-15
Processing and cooling	General	4-8
Labeling and packing	General	4-6

Meat Packing.—The modern packing plant is a typical example of the great progress that has been made in the scientific handling of foodstuffs during the last score of years. Whereas in time gone by, it was primarily a winter industry, modern methods of refrigeration have made it possible on an enormous scale throughout the entire year. Federal Government inspection has done much toward elevating the standards of working conditions and sanitation. The Bureau of Animal Industry of the U. S. Departmtnt of Agriculture require that complete plans for the new buildings be sent to Washington for examination and approval and their recommendations must be carried out. Regulation No. 8 of the Bureau reads that abundant light both natural and artificial must be furnished at all times and in all places ex-

cept coolers, curing cellars, etc., although it is advocated that natural light be had here if possible. Painting is also required on all woodwork and must be of a light color so that accumulations of dirt or dust can be readily seen and removed.

A modern establishment of average size is made up of a number of buildings grouped together in a manner best suited for the efficient handling of the various products. Old plants are largely of mill type construction with low ceilings, heavy timbers, beams and many columns which tend to obstruct what little daylight succeeds in entering through the small unfrequently washed windows. On account of the relatively large floor space,

Fig. 11.—A night view of the killing and stripping floor of a modern packing plant, 150-watt bowl enameled Mazda C lamps in shallow dome porcelain reflectors on 10-foot centers, assisted by light colored surroundings, furnish a well diffused illumination of approximately 12 ft.-c. intensity.

little daylight penetrates the spaces remote from the windows and artificial light has to be employed at all times. Small interior rooms, curing cellars, coolers, and passageways usually have no provisions for daylighting.

Modern buildings as now constructed under government approval are usually planned so that daylight can penetrate to the

maximum depth. This limits the width of the buildings to approximately 80 feet. Construction is usually of the mill type with bays 16 feet by 16 feet.[6] As compared to the older houses, ceilings are usually higher, columns fewer, windows larger and daylight conditions much improved.

The working operations in meat packing consist of slaughtering, removal of hides, pelts or bristles, as the case may be, removal of the internal organs, heads and feet, followed by a thorough scrubbing and washing. The carcasses are then re-

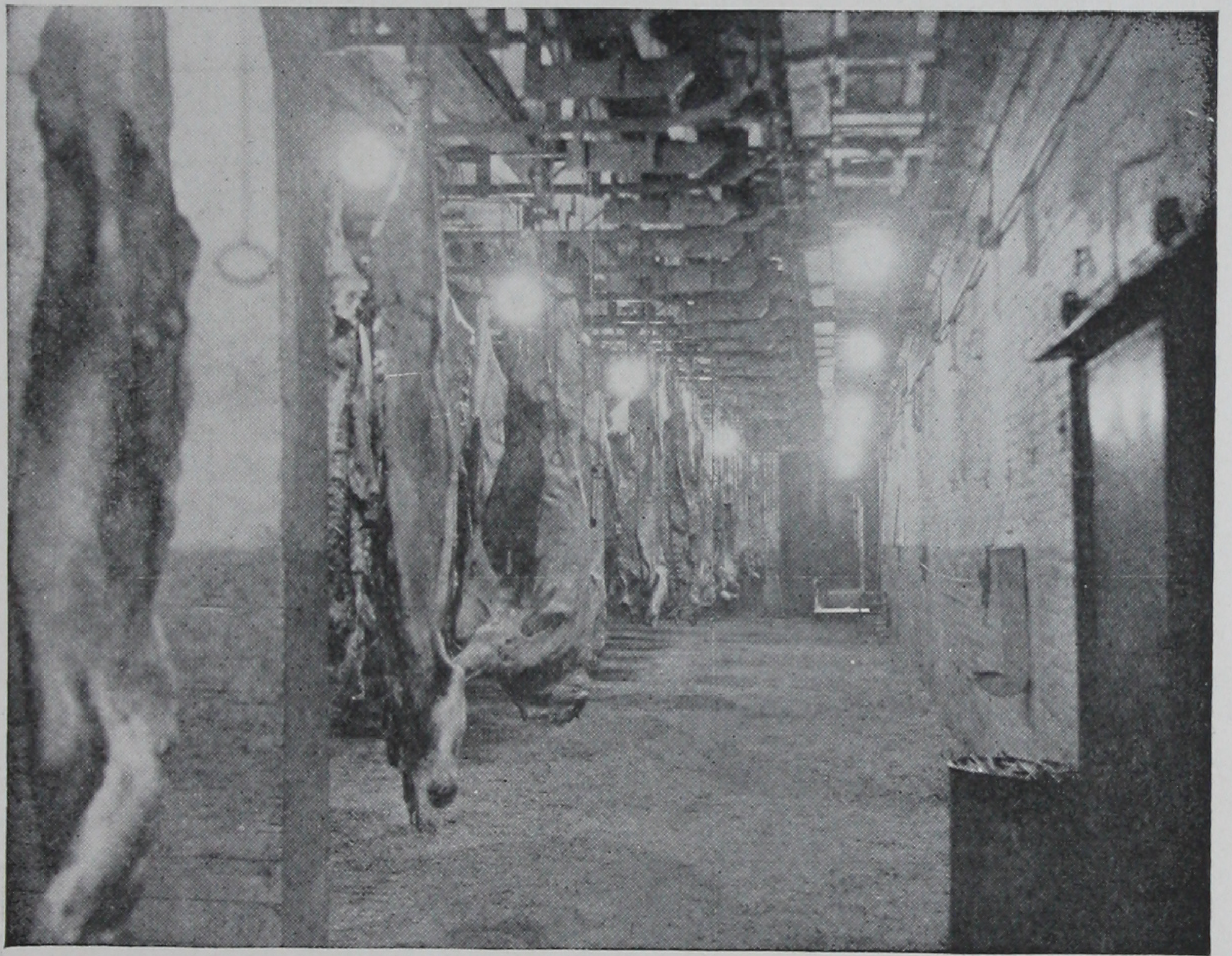

Fig. 12.—Night view of a typical "Sales Cooler" illuminated by 60-watt bare Mazda B lamps on centers 8 x 6 feet producing an average intensity of 8 ft.-c. The light surroundings aid in the utilization of light and minimization of glare from the unshielded lamps.

moved to the coolers where they hang until shipped or until they are sent to the cutting department for dissecting preparatory to curing, sausage making or canning.[7]

[6] For a more detailed description of modern packing house construction, see "Packing and Cold Storage Construction" by H. Peter Henschien, Publishers, Nickerson and Collins, Chicago, Ill.

[7] For a more detailed discussion of the operations involved in meat packing, see "Food Industries" by Vulté and Vanderbilt, pages 200-209. Publishers, Chemical Publishing Co., Easton, Pa.

Although government regulations have done much toward improving sanitary and daylight conditions, artificial lighting in many plants is still far from a satisfactory standard. The equipment in use is of a wide and in many cases antiquated variety. Carbon filament and vacuum lamps are still commonly used while glaring units are very common. In many cases where reflectors are used, they are not of a type designed for the lamps in connection with which they are being operated. Local lighting, employing groups of small bare lamps is frequently used at the cutting tables, etc., the very places where comfortable and adequate light is most essential.

In operations such as the stripping of hides, dressing and inspecting, a comparatively high intensity of well diffused light is absolutely essential, to the maintenance of a high grade of product, the minimization of spoilage and the prevention of accidents such as cuts. (See Figure 11). Sales cooler lighting should be of a comfortable and effective character inasmuch as it is there that the prospective buyers examine the carcasses and make their selections. (See Figure 12). A medium intensity of general light will suffice for most all other working spaces.

The following tabulation indicates the recommended practice for the lighting of packing houses:

Process or operation	Type of illumination	Intensity ft-c.
Slaughtering	General	3-6
Hide stripping and dressing	General	8-12
Washing	General	8-10
Inspection	Localized general	12-14
Cooling	General	4-8
Cutting	Localized general	8-10
Cooking, grinding, sausage stuffing, etc.	General	6-8
Curing		2-4

Fish Packing.—In common with the other food industries, a field exists here for the application of modern methods of lighting. Rarely does one encounter systems laid out with any degree of uniformity and intensities prevail which are far too low for efficient production.

The buildings where fish packing is carried on are of such a character as to permit effective lighting. There are practically no overhead obstructions and the work is largely done in a hori-

zontal plane on benches. Strictly general illumination with the standard types of equipment is applicable.

In the salt fish industry, the fish are removed from the boats in baskets or by other means, the entrails and heads are removed, the carcass split and salted. After being placed on large trays, the product is carried to the open for suncuring. The bones are carefully removed for certain types of product and the material is then cut, weighed and packed. With the other methods of preserving generally similar steps of manufacture are followed.

Standard weather-proof equipment on brackets or floodlighting projectors can well be applied for lighting the unloading platform and curing yard where it is likely that work will be necessary after sunset.

An interesting application of light is in connection with the examination of the product for foreign material. The accurate type of color identification unit is recessed on the inspection bench so that the fish can be viewed by transmitted light enabling one to instantly detect and remove any foreign matter.

With this arrangement, the precaution should be taken to prevent the fish coming in contact with hot absorbing plate of the color identification unit. An air space should be provided between this and a clear glass plate on which the fish are inspected.

The following tabulation indicates the recommended practice for the lighting of fish packing plants.

Process or operation	Type of illumination	Intensity ft-
Cleaning, splitting and salting	General	3-6
Curing	General	2-4
Boning, cutting and packing	General	5-10

Ice Cream Manufacturing.—Ice cream frequently termed the "Great American Dessert" was developed as a frozen milk product in northern Italy. The industry is one which has expanded with surprising rapidity, particularly in recent years. In nearly all large cities are found plants both large and small usually of modern factory construction devoting their entire efforts to ice cream production.

The manufacturing consists of the mixing of the ingredients freezing and holding in coolers until shipped.

Lighting practice in this industry is among the poorest found in any of the so-called food industries. Proprietors of some

plants attempt to excuse this state of affairs by referring to the seasonal nature of their business but the majority of the plants operate during the hours of darkness as well as light especially during the summer months.

General illumination of a modern intensity answers all lighting demands.

The following tabulation indicates the recommended practice for the lighting of ice cream plants.

Process or operation	Type of illumination	Intensity ft-c.
Mixing	General	4-6
Freezing	General	4-6
Coolers	General	3-4

Chocolate and Candy Manufactories.—The ever growing public demand for sweets has elevated the candy industry from the re-

Fig. 13.—Night view of wrapping room in a modern candy factory. An average intensity of five foot-candles is provided on the working tables by the general lighting system, consisting of 75-watt Mazda C lamps in deep bowl reflectors mounted 7 feet above the tables on 10-foot centers.

tail store basement shop to the modern daylight factory of irreproachable construction though there still remain many of the smaller establishments.

The conversion of cacao bean, as received by the chocolate manufacturer, into the chocolate of commerce involves processes which are known as cleaning and sorting, husking, sieving, and winnowing, milling or grinding, fat extraction, crushing, sifting, mixing, refining, kneading, moulding, setting or cooling and wrapping.[8]

The principal operations in candy making consist of mixing, cooking, moulding, dipping and wrapping.

Lighting conditions in this industry vary widely. Several of the large plants inspected were found to be using admirably

Fig. 14.—Night view of wrapping room in an up-to-date chocolate factory. An average intensity of five foot-candles is furnished on the working plane, by an admirably supplied system of totally indirect lighting comprising 300-watt units on 16-foot centers.

applied general illumination with intensities ranging from 4 to 6 foot-candles. (See Figs. 13, 14 and 15). Others were found to be using haphazard applications of bare lamps on drop cords and these apparently are still in the majority.

[8] For a detailed description of chocolate manufacture see "Cocoa and Chocolate" by R. Whymper, Publishers, J. A. Churchill, 7 Great Marlborough St., London, England.

There are no difficult problems involved in the lighting of these factories and general illumination properly applied is usually found well suited to all areas.

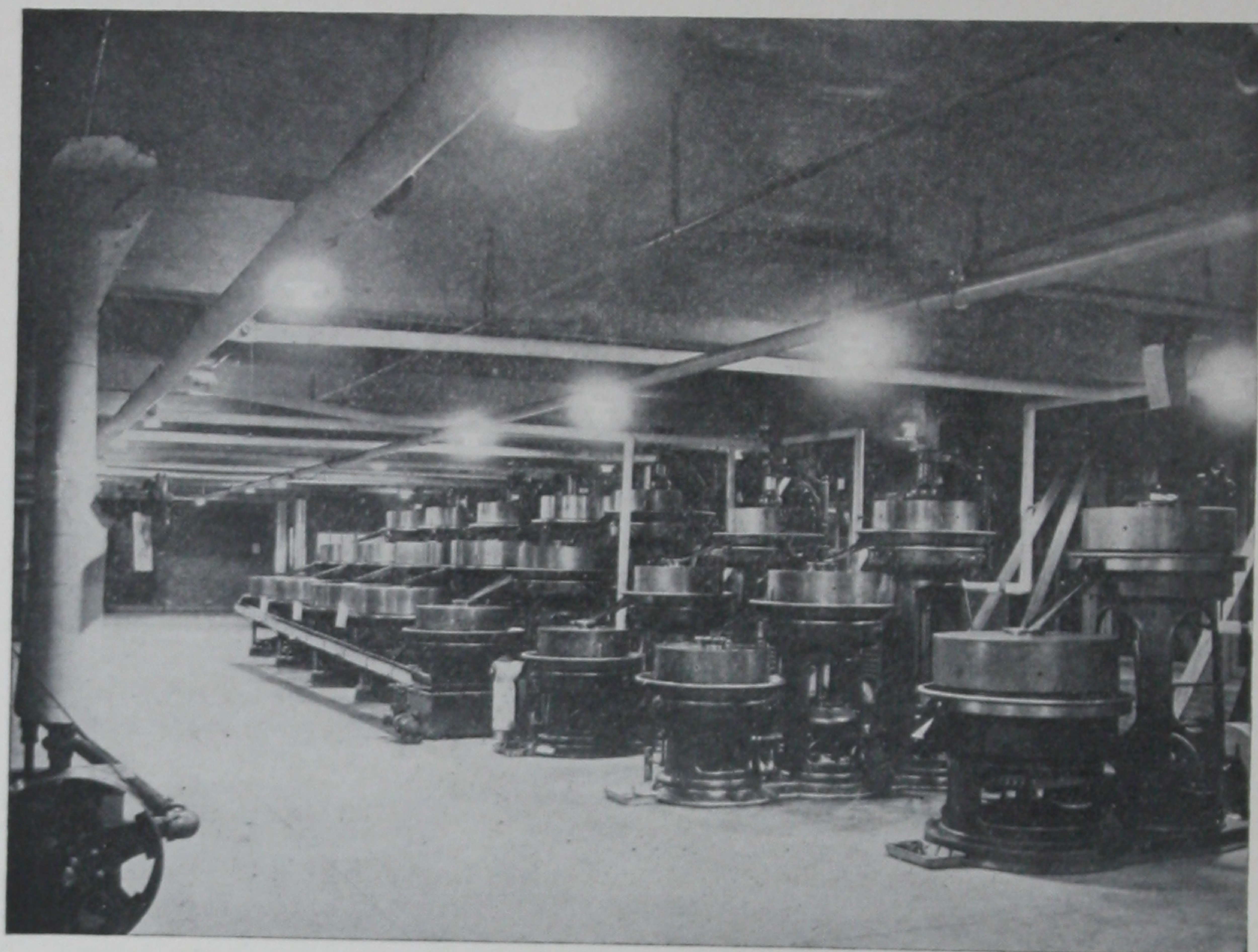

Fig. 15.—Night view illustrating the application of general lighting to the illumination of chocolate grinding machines. Seventy-five-watt Mazda C lamps 11 feet above the floor in deep bowl reflectors on 10-foot centers produce a well diffused intensity of six foot-candles.

The following tabulation indicates the recommended practice for the lighting of chocolate and candy factories:

Process or operation	Type of illumination	Intensity ft-c.
Chocolate		
Cleaning and sorting	General	4-8
Husking, sieving and winnowing	General	4-8
Milling	General	4-8
Fat extraction	General	4-8
Crushing, sifting, mixing and refining	General	4-8
Kneading and moulding	General	4-8
Setting	General	4-8
Wrapping	General	5-10
Candy		
Mixing	General	4-8
Cooking	General	4-8
Moulding and dipping	General	5-10
Wrapping	General	5-10

Fruit Packing.—As compared with the intricacies of manufacture encountered in many of the food industries, fruit packing is of extreme simplicity. The fruit, upon being harvested, is usually taken either to rudely constructed tables built in the open at a convenient part of the orchard or to more or less substantially constructed sheds for cleaning, grading and in the case of choice fruits, wrapping.

By far the most important operation in fruit packing is that of grading. In the case of apples, pears, peaches, apricots, etc., this consists of the division of the crop into three groups while in some citrus fruits as many as five gradations are made. Classification is carried on with careful reference to size, shape, color, degree of ripeness, blemishes, bruises, etc. Extremely good light of a character enabling fairly accurate color discrimination is highly essential in this work. It is found that most packers depend almost entirely upon north skylight, suspending operations with the coming of darkness and on cloudy or rainy days.

Owing to the short harvest season and relatively high perishability of most fruits the problem of prompt grading is of serious importance. In at least one large California orange and lemon packery a practical solution has been reached by the adoption of proper lighting. The scheme employed involves the use of Daylight Mazda Lamps in deep bowl porcelain, enamel steel reflectors hung 3 feet above the grading tables and producing a uniform intensity of approximately 8 foot-candles. It is claimed that carefully conducted tests show that fruit may be graded under this light with the same degree of accuracy as under normal daylight and further that the workers prefer the artificial illumination.

The introduction of this lighting system has made possible double shift operation and according to the plant manager will make possible the saving of thousands of dollars in plant additions to say nothing of the increasing output and hastening of marketing.

In cleaning and wrapping, a medium intensity of general lighting supplied by standard units, localized with reference to the working tables is found satisfactory.

The following tabulation indicates the recommended lighting practice for fruit packing establishments.

Process or operation	Type of illumination	Intensity ft-c.
Cleaning	Localized general	3-6
Grading	Local (daylight lamps)	8-12
Wrapping	Localized general	3-6

Milk Treating Plants.—Milk plays a more important role in the average daily life than any other beverage, usually being found on every table either in its natural, condensed, or evaporated form. Because it becomes easily contaminated, cleanliness is an absolute necessity in its handling and to these ends, good light is an important aid.

Dairying and treating plants are characterized by their clean and light interiors. Walls and ceilings are usually finished with good white paint or white tile and windows and skylights are liberally provided.

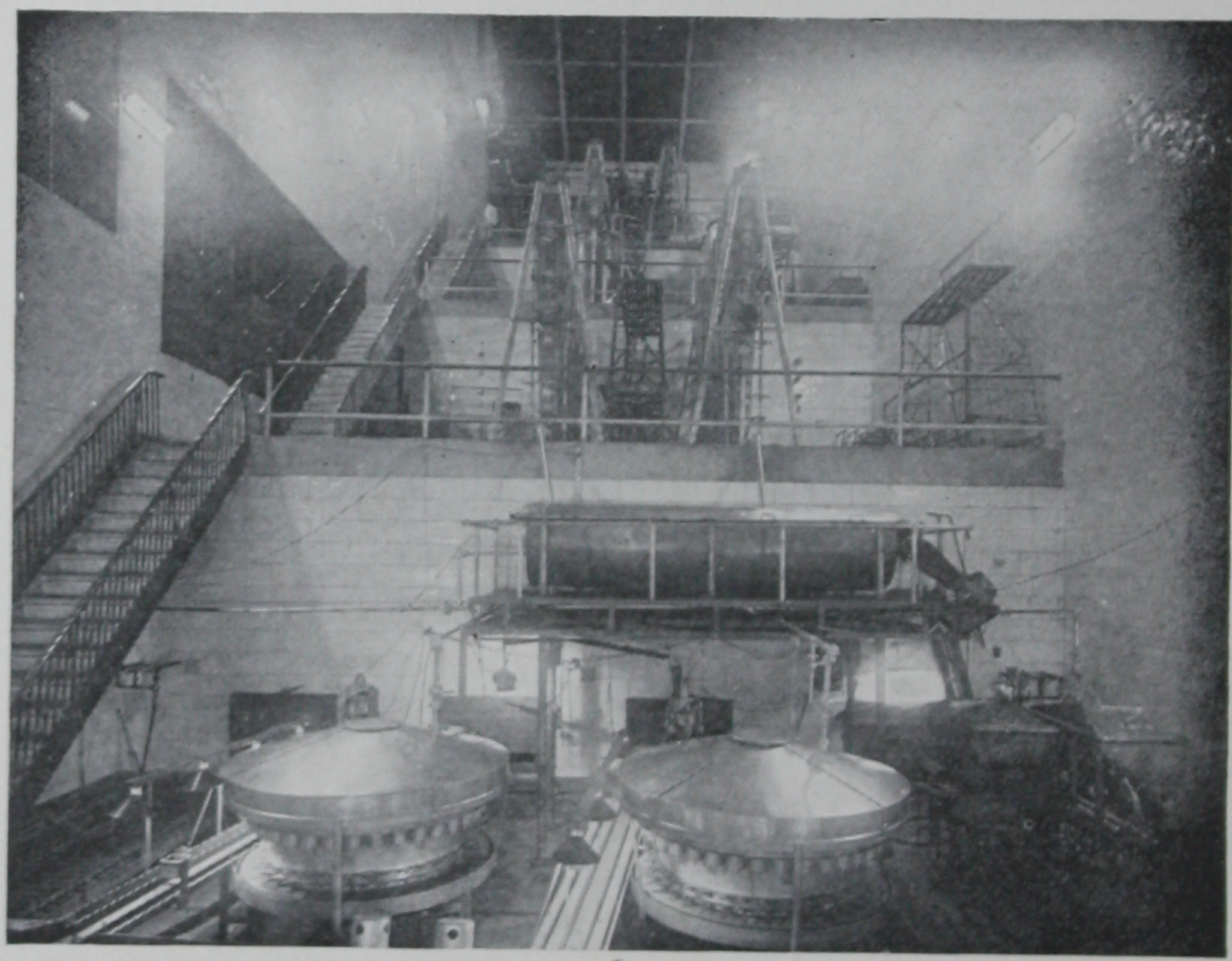

Fig. 16.—Night view of pasteurizing and bottling room in a modern milk treating plant. General lighting of an average intensity of 5 ft.-c. is provided by white tile lined side wall troughs fitted each with four 40-watt lamps. Local lighting of an intensity of 12 ft.-c. for inspection at the take off points on the bottling machine is provided by steel reflectors and 60-watt lamps.

The processes involved in marketing fresh milk may be briefly summarized as pasteurizing, bottling and canning, cooling and shipping.

Pasteurizing is a process of heating and rapidly cooling which results in the destruction of a considerable part of the bacterial life and improvement in the keeping qualities of the milk. It is the most important process encountered in milk handling, and is attended by the greatest of care. Bottling is done by automatic machines, each bottle being inspected after being capped or sealed by an operator who lifts the bottles from the machine and places them on a conveyor on which they are carried to the coolers where they are held until shipped.

General lighting supplemented by local or localized general lighting at inspection points is usually employed in milk treating plants and is well adopted to the work carried on. (See Figure 16).

Fig. 17.—Night view of a well lighted shipping platform of a large city milk distributing and pasteurizing plant. An average intensity of 2 ft.-c. is provided by the overhead lighting units.

Inasmuch as most milk shipping especially in the case of city distribution is done during the night or early morning, good shipping platform lighting is important and may usually be obtained by properly applied general lighting. (See Fig. 17).

No particular lighting problems are encountered in condensing or evaporating plants and general lighting of a medium intensity is found to answer all requirements.

The following tabulation indicates the recommended lighting practice for milk treating plants.

Process or operation	Type of illumination	Intensity ft-c.
Pasteurizing, bottling and capping	General	4-8
Bottle inspection	Local or localized general	10-12
Cooling	General	2-4
Can and bottle washing	General	2-4
Shipping	General	1-2
Condensing	General	4-8
Evaporating	General	4-8

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